Surgical Re-establishment of the Arterial Circulation in the Leg in Buerger's Disease : with Special Reference to the Efficacy of Prostaglandin E1 Used Concomitantly

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Surgical Re-establishment of the Arterial Circulation in the Leg in Buerger's Disease—with Special Reference to the Efficacy of Prostaglandin E_1 Used Concomitantly

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Buerger's disease typically attacks young males, involving the smaller arteries at the periphery of the extremities with their extensive, multiple occlusion and often leading to gangrene. The exact pathogenesis remains obscure.

Controversy therefore exists concerning the valid policy of treatment for the disease. Surgical re-establishment of the arterial circulation in the leg presupposes patency of at least one of 3 arteries: the anterior and posterior tibial and the fibular artery. It is generally believed that such a requirement is met in only 15–25 per cent of cases and that an attempt at re-establishing the arterial circulation by an ordinary procedure, if made, yields no results other than extremely poor with regard to patency of these arteries.

Materials and methods

Arteriography is of importance in determining the indication for surgical intervention. In cases where there is extensive occlusion of the femoral artery, it may sometimes be difficult to locate the lesion even by means of sequential arteriography under lumbar anesthesia, because of failure of contrast medium to reach peripheral arteries beyond the popliteal artery in an adequate amount or because of vasoconstriction impeding arteriographic visualization. Efforts should be made to locate the lesion and determine its extent and severity in a precise manner and to find out peripheral arteries which are patent enough to warrant an attempt to restore the arterial circulation.

Key words: Buerger's disease, Revascularization, Prostaglandin E_1, Intraarterial infusion, Vasodilatation and antithrombosis.
索引語：バージャー病，血行再建，プロスタグランディン E_1，動脈注入，血管拡張・抗血栓.
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Prostaglandin E_1 has the property of inducing peripheral vasodilatation and hence is of help in detecting collateral routes of blood circulation and clearly visualizing blood vessels.

In the present series, arteriography was performed after infusion of 10–15 ng of prostaglandin E_1 into the femoral artery. This method proved to be useful in finding out arteries which were suitable for surgical re-establishment of blood circulation.

There were 8 cases in which prostaglandin E_1 was used concomitantly following surgical re-establishment of blood circulation involving a long bypass graft.

Lumbar sympathectomy had been performed in 5, unsuccessful operation for re-establishment of arterial circulation in 5, and amputation of the toe in 4 cases. In 2 cases there was Buerger's disease developing in one lower limb after amputation of the other.

Case No. 5. A 32-year-old carpenter had his left foot necrotized in April, 1970 and then underwent amputation of the leg under the diagnosis of Buerger's disease. In early Aug., 1977 he developed pain in his right foot. An about 400 meters' walk resulted in pain in the right leg. Later he had pain even at rest with ulceration at the tip of the right 5th toe.

Right femoral arteriography demonstrated occlusion of the superficial femoral artery with a filling defect in the popliteal and the tibial arteries, which were stenotic but still patent.

In Nov., 1977 bypass operation was performed with a saphenous autograft implanted between the femoral and the popliteal artery. The pain and coldness in the affected foot appeared to subside postoperatively. An arteriogram taken on the 10th postoperative day, however,

Table 1. Clinical data for patients undergoing below-knee arterial bypass with Buerger's disease

Patient No.	Age (Yr.)	Sex	Previous surgery
1	19	Male	Amputation of third toe Lumbar sympathectomy Arterial bypass
2	24	Male	Amputation of other extremity Amputation of fourth toe Arterial bypass Lumbar sympathectomy
3	48	Male	None
4	50	Male	Lumbar sympathectomy Arterial bypass
5	32	Male	Amputation of other extremity Amputation of fifth toe Arterial bypass Lumbar sympathectomy
6	32	Male	Lumbar sympathectomy Amputation of fifth toe
7	44	Female	Arterial bypass
8	56	Male	None

showed that the graft had got clogged. Lumbar sympathectomy was performed in Jan., 1978.

The finding of both the anterior and the posterior tibial artery having been involved led us to undertake bypass operation on the fibular artery in March, 1978.

A section of the umbilical vein, 4.5 mm in diameter, was used as the bypass graft, since no venous graft of adequate length was available. Proximally the graft was anastomosed with the common femoral artery. The fibular artery had an outer diameter of 1.9 mm and a blood flow of 25 ml per min. The next morning the graft became obstructed, necessitating prompt removal of the thrombus.

Femoral arteriography during operation failed to visualize the bypass graft, probably because of strong resistance to blood flow in the distal portion of the graft. Local intraarterial infusion of prostaglandin E_1 was started at once in order to cope with possible re-occlusion. The rate of infusion was 4 ng/min/kg initially but then reduced to 2–3 ng/kg/min because of pain, redness and swelling of the leg that developed on the 2nd day. Intraarterial infusion of the substance was discontinued after 7 days.

The sites of anastomosis, proximal and distal, are shown in Table 2. The lateral approach of DARDIKN et al.[3] involving resection of the fibula was employed in 2 cases where a bypass graft was anastomosed with the fibular artery and in cases where the anterior tibial artery was so operated on. The umbilical vein was used as a graft in all but 1 case in which a venous autograft was implanted for anastomosis with the anterior tibial artery.

Prostaglandin E_1 was administered for 7–12 days, the mean dose being 2 ng/kg/min, as shown in Table 3. It was dissolved in heparinized physiological saline solution before being infused continuously into the graft through a silicone tube. Bleeding on withdrawal of the tube can be effectively controlled by applying an elastic surgical suture to the site of insertion beforehand.

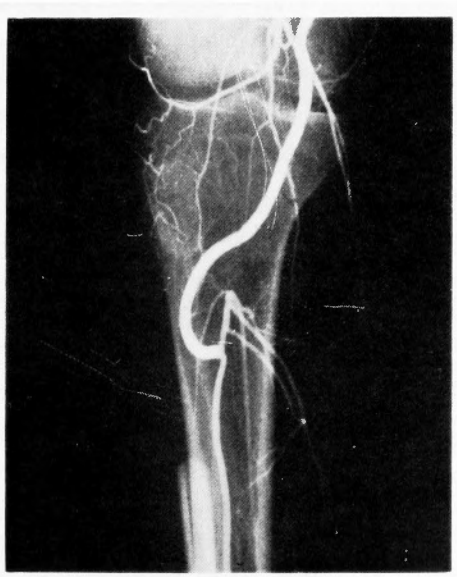

Fig. 1. Postoperative angiogram of a femoroperoneal bypass by lateral approach (Patient No. 5).

Table 2. Types of bypasses in eight patients with Buerger's disease

Types of bypass	No. of patients	Proximal anastomosis	
Posterior tibial bypass	5	Internal iliac artery	1
		Common femoral artery	2
		Femoral artery	2
Fibular bypass	2	Common femoral artery	1
		Femoral artery	1
Anterior tibial bypass	1	Femoral artery	1

Treatment with prostaglandin E_1 should be discontinued or continued in reduced doses if severe side-reactions occur in the limb so treated, such as redness, swelling, fever or pain, although it is to be noted that the patient must be compelled to endure such adverse reactions to some extent. The surgery involves fasciotomy and hence is unlikely to cause damage to the arterial circulation even if severe swelling as such a reaction occurs.

Aspirin and warfarin were administered following discontinuation of prostaglandin E_1.

Results

In 1 case the graft became infected and obstructed 1 month after implantation. Re-operation following cure of infection, however, has kept it well patent for the ensuing year. In a case where the longest bypass graft was used in the present series to establish communication between the internal iliac and the posterior tibial artery, prostaglandin E_1 was discontinued after 10 days of its use, to find that obstruction of the graft occurred with pulsation ceased on the 14th day of affection. In this case re-operation is under contemplation along with appraisal of the appropriateness of the method of administration of prostaglandin E_1 employed.

The longest duration of patency of the graft is 2 years. In all these but 1 case in which the graft became obstructed there has been abatement of the lesion as well as relief of pain at rest and an improvement in ulcer and gangrene.

Table 3. Doses of prostaglandin E_1

Patient No.	Doses ng/Kg/min (Mean)	Days of administration
1	4→2 (2.6)	7
2	4→2 (2.5)	7
3	3→1.5 (1.8)	10
4	2→2 (2.0)	10
5	3→2 (2.2)	9
6	4→2 (2.6)	7
7	2→1.5 (1.8)	12
8	2→2 (2.0)	10

Table 4. Follow-up, including angiography, have continued to show a satisfactorily functioning graft except one occluded two weeks after implantation, internal iliacposterior tibial bypass

Follow-up extending up to 2 years

Interval	No. of Patients
<6 mon.	1
6 mo. to 1 yr.	3
1 yr. to 2 yr.	3

Discussion

CARLSON et al.[1] reported that angiograms of high resolution were obtained with prostaglandin E_1 administered in conjunction, i.e., by intraarterial infusion of 0.7 μg per min 10 min before peripheral arteriography. Concomitant treatment with prostaglandin E_1 appears to be essential in deciding on reestablishment of circulation through arteries of the lower limb especially in cases of extensive obstruction of the femoral artery.

There are difficulties to overcome in achieving improved patency of a long bypass graft that communicates peripheral arteries with one another. Expanded polytetrafluoroethylene has been used experimentally as a vascular prosthesis for the restoration of peripheral arterial circulation but with variable results. No such prosthesis can be used in the presence of a slow-flow state, such as poor distal run-off.

Venous autograft is considered most suitable at present for surgical re-establishment of circulation through medium- or small-sized arteries, as it has proved to be satisfactory in actual practice[4,6]. A graft of appropriate size and length is not always available, however. In Buerger's disease, in particular, because of the venous system being also involved, an autograft from the great saphenous vein may sometimes be unusable. Hence there is a demand for a new vascular substitute that can be used in place of an autologous vein.

DARDIK et al.[5] used the glutaraldehyde-treated human umbilical vein clinically with satisfactory results.

As regards an ideal vascular prosthesis, complete healing refers to its being incorporated into connective tissue and autogenized there with revascularization and endothelial formation. An implant from the umbilical vein treated with glutaraldehyde will never assimilate with the host tissue. In view of the fact that such an implant has the tunica interna intact, which has an antithrombotic property, the host tissue making inroads into the implant may be rather deleterious, giving rise to degeneration of the latter.

A study with prostaglandin E_1 administered intraarterially to the lower limb showed that the blood flow doubled with 1–3 ng/kg of the substance. The blood flow increased up to 4 times with 100 ng/kg/min delivered by continuous intraarterial infusion and then returned to the initial level in 10–20 min[7].

CARLSON AND ERIKSSON[2] found the substance highly useful in 4 cases of severe obstruction of arteries of the leg, when given intraarterially at a rate of 1 ng/kg/min for 10 min per hr over a period of 1–3 days.

SHIONOYA et al.[10] stated that the substance is effective in ischemic ulcer due to peripheral arterial occlusion, the appropriate dose being 0.05–0.01 ng/kg/min.

Adverse side-reactions to the substance led SAKAGUCHI et al.[8] to recommend a rate of infusion of 0.1–0.5 ng/kg/min.

Reported duration of treatment with the substance is generally 1 or 3 weeks, although some investigators found it useful even when given intermittently for 1–3 days.

A sensation of heat and redness develop immediately after infusion of prostaglandin E_1, followed by swelling, redness and pain of marked severity at an interval of 1–2 days. Clinical laboratory studies demonstrate inflammatory changes such as leukocytosis, increased BSR, a positive CRP test, and an elevation in gamma-globulin level.

Histologically, there was marked edema with round cell infiltrates around arterioles and capillary vessels, changes which suggest increased vascular permeability. Although not favorable to Buerger's disease in which degeneration of the tunica interna is responsible for thrombotic obstruction of vessels, such changes never led to progress or induction of the original disease.

Prostaglandin E_1 is known to inhibit agglutination of human platelets by various agglutinants. Intraarterial administration of 0.1–1.0 ng/kg min of the substance reportedly resulted in inhibition of agglutination of platelets in local venous blood of patients with peripheral arterial obstruction[9].

Surgical intervention is believed to be not indicated in cases where vascular occlusion of thrombotic origin develops early in the postoperative course, particularly within 48 hrs, unless there is a blunder committed during operation. Protracted vasospasm may also be present in cases of poor run-off.

The use of prostaglandin E_1 makes it feasible to make most of and promote further development of the well-developed circulatory collaterals characteristic of Buerger's disease in young patients and also to relax highly sympatheticotonic peripheral vessels postoperatively with resultant improvement in distal run-off. The effect of prostaglandin E_1 as an antithrombotic agent, if combined with a properly selected material for implantation, can make surgical treatment indicated for a wider range of conditions.

DARDIK et al.[5] stated that bypass grafts implanted into arteries of the leg, if ever obstructed, invariably became so within 1 week of operation. REICHLE AND TYSON et al.[11] also found bypass operation, if unsuccessful, to prove to be so soon afterwards, the cause of failure being poor run-off and unsatisfactory communication between the graft and the pedal arch.

The tunica interna of the umbilical vein as viewed grossly 7–10 days after isolation has an irregular surface covered by a reddish, rough fibrin film. This finding appears to make it advisable to inhibit thrombocytic function for 2 weeks or more, even in consideration of the marked antithrombotic feature of the umbilical vein.

On the other hand, the aforementioned observations of previous investigators on the time of

onset of vascular obstruction due to thrombosis suggest that 7–12 days may suffice for that purpose. If no trouble occurs during that period, then long-term patency of the graft can be expected. Incidentally, aspirin and warfarin were used in all cases while precautions were exercised against bleeding tendency.

During treatment with prostaglandin E_1 or surgical intervention there was no recrudescence or aggravation of Buerger's disease, which is a form of angiitis. Restoration of the circulation resulted not only in relief of pain at rest and subsidence of ulcer and gangrene but also in abatement of the lesion, no later occurrence of obliteration being disclosed even by a long-term follow-up study. It may be concluded that surgical re-establishment of blood circulation should be undertaken to cope with Buerger's disease.

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和文抄録

バージャー病における下腿動脈血行再建術
Prostaglandin E_1 の併用効果について

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バージャー病で下腿動脈への血行再建手術可能な症例は多くはなく，またたとえ血行再建術を施行してもその開存成績はきわめて悪いとされてきた．

Prostaglandin E_1 は著しい血管拡張作用による血流量増加が知られている．同時に同薬剤には血小板凝集能の抑制作用があり抗血栓剤としても有効である．

Prostaglandin E_1 を血行再建手術直後より動脈注入を開始し，従来の方法では早期閉塞をまぬがれえなかったと思われる long bypass を必要とした8症例に効果的であった．積極的にこの方法を併用して血行再建術にとりくむべきであると考えている．